ASMEX.447A PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Number:	10/799,335	Confirmation Number: 6213
Applicant:	Tomasini et al.	
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Art Unit:	1722	
Examiner:	G. Nagesh Rao	
Customer Number:	20,995	

Commissioner for Patents
Post Office Box 1450
Alexandria, Virginia 22313-1450

AMENDED APPEAL BRIEF

Sir:

Filed herewith is an Amended Appeal Brief for consideration in U.S. Patent Application 10/799,335, entitled "Method to Planarize and Reduce Defect Density of Silicon Germanium". This Amended Appeal Brief is being filed in response to the Notification of Non-Compliant Appeal Brief sent on 23 May 2007.

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REAL PARTY IN INTEREST

The real party in interest in the present application is ASM America, Inc., the assignee of record.

RELATED APPEALS AND INTERFERENCES

Appellant does not know of any prior appeals, pending appeals, judicial proceedings, or interferences that may be related to, directly affect, be directly affected by, or have a bearing on the Board's decision in this appeal.

STATUS OF CLAIMS

Claims 1–19 and 21–53 are pending in this application, and are attached hereto as an appendix. All of the pending claims were finally rejected by the Examiner, and are the subject of this appeal.

STATUS OF AMENDMENTS

No claims have been amended subsequent to the Final Office Action mailed on 1 November 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention relates generally to methods for blanket deposition of silicon germanium films. Each independent claim is summarized below, with reference to the originally-filed specification and drawings as required by 37 C.F.R. § 41.37(c)(1)(v). These citations are provided to enable the Board to more quickly determine where the claimed subject matter is described in the application, and are not intended to limit the claims.

Independent Claim 1 is directed to a method for blanket deposition of a silicon germanium film. In the claimed method, a silicon source, a germanium source and an etchant are intermixed to form a gaseous precursor mixture. See paragraph **[0011]**. The gaseous precursor mixture is flowed over a substrate under chemical vapor deposition conditions. See paragraphs **[0019]** and **[0020]**. A blanket layer of epitaxial silicon germanium is deposited over the substrate, the layer being formed from at least some of the components of the gaseous precursor mixture. See paragraph **[0014]**.

Independent Claim 19 is directed to a method for depositing a blanket silicon germanium film over a substrate. In the claimed method, a single crystal silicon substrate is provided in a chemical vapor deposition chamber. See paragraph **[0008]**.

Masses of silicon precursor, germanium precursor and etchant are supplied into the chamber. See paragraph **[0011]**. The mass of etchant is less than the masses of silicon precursor and germanium precursor combined. See paragraph **[0018]**. A blanket silicon germanium film is deposited over the substrate. See paragraph **[0014]**.

Independent Claim 39 is directed to a method of blanket depositing a silicon germanium film. In the claimed method, silicon and germanium source gases are intermixed, and an etchant is added to the intermixed source gases to form a gaseous precursor mixture. See paragraph **[0011]**. The mass of etchant added to the intermixed source gases is less than a mass of etchant added to the intermixed source gases in a selective deposition process. See paragraph **[0012]**. The gaseous precursor mixture is flowed over a substrate under chemical vapor deposition conditions. See paragraphs **[0019]** and **[0020]**. A blanket layer of epitaxial silicon germanium is deposited onto the substrate. See paragraph **[0014]**.

Independent Claim 44 is directed to a method of performing blanket deposition of a film. In the claimed method, a single crystal substrate is provided in a chemical vapor deposition chamber. See paragraph **[0008]**. A mass of germanium source gas and a mass of etchant are supplied into the chamber. See paragraph **[0011]**. The mass of etchant is less than the mass of germanium precursor. See paragraph **[0018]**. A film comprising germanium is blanket deposited over the single crystal substrate. See paragraph **[0014]**.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection presented for review are as follows:

(a) Independent Claims 1, 19, 39 and 44 stand rejected as being anticipated by the teachings of U.S. Patent Application Publication 2003/0157787 ("Murthy");

(b) Dependent Claims 2–4, 6, 9–15, 21–28, 31, 32, 34, 40–43, 45 and 51–53 stand rejected as being anticipated by the teachings of Murthy;

(c) Dependent Claim 5 stands rejected as being unpatentable over Murthy in view of Mayer et al., "Electronic Material Science: For Integrated Circuits in Si and GaAs" at page 40 ("Mayer");

(d) Dependent Claims 7, 8, 16–18, 29, 30, 33, 35–38 and 46–50 stand rejected as being unpatentable over Murthy in view of what the Examiner considers to be Appellants' admitted statements of prior art.

ARGUMENT

1. Summary of the teachings of U.S. Patent Application Publication 2003/0157787 ("Murthy").

Murthy teaches two fundamentally distinct methods for forming germanium films over a graded silicon germanium buffer layer on a semiconductor substrate. Figure 1 and Paragraphs **[0021]** through **[0025]** of Murthy describe a method for **blanket** deposition of such a structure. As indicated by operational block 108 of Figure 1, this method involves simultaneously providing both a silicon source gas and a germanium source gas to a deposition chamber. Figure 3 and Paragraphs **[0027]** through **[0031]** describe a method for **selective** deposition of a graded SiGe—Ge film over exposed regions defined by a SiO_2 mask. As indicated by operational blocks 306 and 308 of Figure 3, this embodiment involves simultaneously providing a silicon source gas, a germanium source gas **and an etchant** to a deposition chamber. Murthy makes abundantly clear that, in the second embodiment, the etchant is used for the purpose of achieving selective deposition. For example, Paragraph **[0027]** of Murthy specifically teaches that

> A hydrochlorine source gas (e.g., HCℓ) is used to help to maintain the selectivity in the deposition of the graded SiGe—Ge film in that the HCℓ strips off (etches away) any SiGe and/or Ge that may be formed on the SiO_2 layer. The HCℓ also suppresses the nucleation of the graded SiGe—Ge over the SiO_2 layer. The resulting graded SiGe—Ge film is less rough and the film's threading dislocation density is dramatically improved.

Murthy also characterizes the presence of an etchant agent as being "**required** to maintain selective deposition". See Paragraph **[0041]** of Murthy (emphasis added).

2. Arguments Corresponding to the Grounds of Rejection.

a. Independent Claims 1, 19, 39 and 44 are not anticipated by the teachings of Murthy.

Independent Claims 1, 19, 39 and 44 stand rejected as being anticipated by Murthy. To anticipate a claim, a single prior art reference must disclose each and every element of the claimed invention, **as they are arranged** in the claim. *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1458, 221 U.S.P.Q. 481 (Fed. Cir. 1984).

Murthy clearly does not disclose a single embodiment that teaches the claimed elements as they are arranged in independent Claims 1, 19, 39 and 44. Independent Claims 1, 19, 39 and 44 recite methods that involve **blanket** deposition using both a germanium source (or a germanium precursor) and **an etchant**. In contrast, the embodiments in Murthy that disclose use of an etchant are embodiments for performing selective deposition, while the embodiments in Murthy for performing blanket deposition do not use an etchant. The Examiner has taken the position that the teachings of Murthy's blanket deposition embodiments (**without** use of an etchant) and Murthy's selective deposition embodiments (**with** use of an etchant) are "combinable" and "incorporate each other's basic techniques when need be." See page 7 of the Final Office Action mailed on 1 November 2006. Thus, the Examiner has explicitly acknowledged that some combination of the Murthy embodiments is necessary to obtain the claimed invention.

Based on the foregoing, it is clear that the Examiner is improperly combining features of the Murthy method for blanket deposition (where etchant **is not** supplied to the deposition chamber) with features of the Murthy method for selective deposition (where etchant **is** supplied to the deposition chamber). In actuality, the two Murthy methods are treated by Murthy as separate, incompatible, and in fact, mutually exclusive. If the Examiner wishes to modify any of the embodiments of Murthy, the appropriate statutory basis for doing so could only be 35 U.S.C. § 103.

Based on the foregoing, Appellants respectfully submit that Murthy does not anticipate independent Claims 1, 19, 39 and 44, and respectfully request that the Examiner's rejection of these claims be reversed by the Board.

As expounded above, if the Examiner wishes to modify or combine any of the embodiments of Murthy, the appropriate statutory basis for doing so could only be 35 U.S.C. § 103. However, the Examiner has not presented any analysis explaining why the proposed modification of Murthy would be obvious under this statute. Instead, the Examiner has steadfastly maintained that Murthy **anticipates** independent Claims 1, 19, 39 and 44. Nonetheless, even if the Examiner had performed an analysis under 35 U.S.C. § 103, the only possible conclusion would be that it would not be obvious to modify the teachings of Murthy to obtain the claimed invention.

The Examiner's position requires a legally unsupported modification of the embodiments of Murthy. "Even when obviousness is based on a single prior art reference, there must be a showing of a suggestion or motivation to modify the teachings of that reference." *In re Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313. It is insufficient to simply find the claimed features in the prior art generally. Instead, interrelated teachings of multiple patents, the effects of demands known to the design community or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art should all be considered in determining whether a reason exists to combine or modify prior art teachings. *KSR Int'l Co. v. Teleflex, Inc.*, No. 04-1350, slip op. at 14. (U.S. Apr. 30, 2007). This analysis should be made explicit, since obviousness rejections cannot be sustained by mere conclusory statements. *Id.*, citing *In re Kahn*, 441 F. 3d 977 at 988 (Fed. Cir. 2006). In this case, Appellants respectfully submit that an ordinarily skilled artisan would not have found it obvious to combine the Murthy embodiments in the way required to meet the claims; rather, Murthy itself gives reasons for the features that are incompatible with their combination. Etchants are explicitly used for selective depositions and conspicuously absent from blanket depositions.

As indicated previously, Murthy teaches two fundamentally distinct methods for forming germanium films over a graded silicon germanium buffer layer on a semiconductor substrate. The first is a method for performing blanket deposition, in which no etchant is supplied the deposition chamber; the second is a method for performing selective deposition, in which an etchant is supplied to the deposition chamber. The Examiner has taken the position that the teachings of Murthy's blanket

deposition embodiments (**without** use of an etchant) and Murthy's selective deposition embodiments (**with** use of an etchant) are "combinable" and "incorporate each other's basic techniques when need be." See page 7 of the Final Office Action mailed on 1 November 2006.

Given that the explicitly-stated purpose of using the etchant is to achieve selective deposition, an ordinarily skilled artisan would have absolutely no motivation to modify the embodiments of Murthy as the Examiner suggests. In fact, Murthy clearly states that the etchant is used for the purpose of achieving selective deposition. According to these teachings, an ordinarily skilled artisan would certainly have no motivation to use an etchant to obtain the claimed invention, which requires, among other features, using at etchant for blanket deposition.

Based on the foregoing, Appellants respectfully submit that independent Claims 1, 19, 39 and 44 are not obvious in view of Murthy, and respectfully request that the Examiner's rejection of these claims be reversed by the Board.

b. Dependent Claims 2–4, 6, 9–15, 21–28, 31, 32, 34, 40–43, 45 and 51–53 are not anticipated by the teachings of Murthy.

Dependent Claims 2–4, 6, 9–15, 21–28, 31, 32, 34, 40–43, 45 and 51–53 stand rejected as being anticipated by Murthy. Appellants respectfully submit that these claims are allowable over Murthy for the same reasons that the respective independent claims are allowable, in addition to reciting further distinguishing features of particular utility. Thus, Appellants respectfully request that the Examiner's rejection of dependent Claims 2–4, 6, 9–15, 21–28, 31, 32, 34, 40–43, 45 and 51–53 be reversed by the Board as well.

c. Dependent Claim 5 is patentable over Murthy in view of Mayer.

Dependent Claim 5 stands rejected as unpatentable over Murthy in view of Mayer et al., "Electronic Material Science: For Integrated Circuits in Si and GaAs" at page 40 ("Mayer"). Claim 5 depends from independent Claim 1, and further distinguishes the invention of Claim 1 from the cited references. Mayer is cited for teaching the that oxides and nitrides are "equivalents" and does not supply the deficiencies of Murthy discussed above. That is, Mayer does not each use of etchants in blanket deposition of silicon germanium. Therefore, Appellants respectfully submit

that dependent Claim 5 is allowable over the cited references for at least the same reasons that independent Claim 1 is allowable, and respectfully request that the Examiner's rejection of dependent Claim 5 be withdrawn as well.

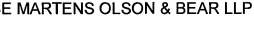
d. Dependent Claims 7, 8, 16–18, 29, 30, 33, 35–38 and 46–50 are patentable over Murthy in view of what the Examiner considers to be Appellants' admitted statements of prior art.

Dependent Claims 7, 8, 16–18, 29, 30, 33, 35–38 and 46–50 stand rejected as unpatentable over Murthy in view of what the Examiner considers to be Appellants' admitted statements of prior art. Appellants respectfully disagree with the Examiner's characterization of the cited portion of the specification, and in any event, the cited portion does not remedy the deficiencies of Murthy. That is, the cited portion does not teach or suggest that it is prior art to use etchants in blanket deposition of silicon germanium. Claims 7, 8 and 16–18 depend from independent Claim 1, and further distinguishes the invention of Claim 1 from Murthy. Claims 29, 30, 33, and 35–38 depend from independent Claim 19, and further distinguishes the invention of Claim 19 from Murthy. Claims 46–50 depend from independent Claim 44, and further distinguishes the invention of Claim 44 from Murthy. Therefore, Appellants respectfully submit that dependent Claims 7, 8, 16–18, 29, 30, 33, 35–38 and 46–50 are allowable over the cited references for at least the same reasons that the respective independent claims are allowable, in addition to reciting further distinguishing features of particular utility. Thus, Appellants respectfully request that the Examiner's rejection of dependent Claims 7, 8, 16–18, 29, 30, 33, 35–38 and 46–50 be reversed by the Board as well.

Respectfully submitted,

KNOBBE MARTENS OLSON & BEAR LLP

Dated: 11 June 2007

By: 
Kyle F. Schlueter
Registration No. 54,912
Attorney of Record
Customer No. 20,995
(310) 551-3450

CLAIMS APPENDIX

Claim 1: A method for blanket depositing a SiGe film comprising:

intermixing a silicon source, a germanium source and an etchant to form a gaseous precursor mixture;

flowing the gaseous precursor mixture over a substrate under chemical vapor deposition conditions; and

depositing a blanket layer of epitaxial SiGe over the substrate, the epitaxial SiGe formed from at least some of the components of the gaseous precursor mixture.

Claim 2: The method of claim 1, wherein an underlying blanket layer is positioned over the substrate, such that the blanket layer of epitaxial SiGe is deposited over the underlying blanket layer.

Claim 3: The method of claim 1, wherein the substrate is patterned with windows of single crystal material framed by a dielectric material.

Claim 4: The method of claim 1, wherein the substrate is patterned with windows of single crystal material framed by a dielectric material, wherein the dielectric material is an oxide.

Claim 5: The method of claim 1, wherein the substrate is patterned with windows of single crystal material within a dielectric material, wherein the dielectric material is a nitride.

Claim 6: The method of claim 1, wherein the substrate is patterned with a shallow trench isolation scheme.

Claim 7: The method of claim 1, wherein the blanket layer of epitaxial SiGe has a surface roughness of less than approximately 40 Å rms.

Claim 8: The method of claim 1, wherein the blanket layer of epitaxial SiGe has a surface roughness of less than approximately 20 Å rms.

Claim 9: The method of claim 1, wherein the substrate comprises a bare single crystal silicon substrate.

Claim 10: The method of claim 1, wherein the epitaxial SiGe film has a greater silicon content at the interface with the substrate than at other points in the film.

Claim 11: The method of claim 1, wherein the silicon source is selected from the group consisting of silane, disilane, trisilane, chlorosilane, dichlorosilane, trichlorosilane, and tetrachlorosilane.

Claim 12: The method of claim 1, wherein the germanium source is selected from the group consisting of germane, digermane, trigermane, chlorogermane, dichlorogermane, trichlorogermane, and tetrachlorogermane.

Claim 13: The method of claim 1, wherein the etchant comprises hydrogen chloride.

Claim 14: The method of claim 1, wherein the etchant is present in an amount that is less than the combined amounts of the silicon source and the germanium source, on a weight basis.

Claim 15: The method of claim 1, wherein the blanket layer of epitaxial SiGe has a greater degree of planarity as compared to a reference blanket layer of epitaxial SiGe deposited under comparable conditions, except in the absence of the etchant.

Claim 16: The method of claim 1, wherein the blanket layer of epitaxial SiGe has a reduced density of defects as compared to a reference blanket layer of epitaxial SiGe deposited under comparable conditions, except in the absence of the etchant.

Claim 17: The method of claim 1, wherein the blanket layer of epitaxial SiGe has an etch pit density of less than 10^7 defects cm^{-2}.

Claim 18: The method of claim 1, wherein the blanket layer of epitaxial SiGe has an etch pit density of less than 10^5 defects cm^{-2}.

Claim 19: A method comprising:

providing a single crystal silicon substrate in a chemical vapor deposition chamber;

supplying a mass of silicon precursor into the chamber;

supplying a mass of germanium precursor into the chamber;

supplying a mass of etchant into the chamber, wherein the mass of etchant supplied is less than the mass of silicon precursor and the mass of germanium precursor, combined; and

depositing a blanket SiGe film over the substrate.

Claim 20 (cancelled).

Claim 21: The method of claim 19, wherein the substrate is a bare wafer.

Claim 22: The method of claim 19, wherein the substrate is patterned with windows of single crystal material with a dielectric material.

Claim 23: The method of claim 19, wherein the substrate is a wafer having a first blanket layer deposited thereover, and wherein the SiGe film is deposited as a second blanket layer over the first blanket layer.

Claim 24: The method of claim 19, wherein the chemical vapor deposition chamber is a single wafer chamber.

Claim 25: The method of claim 19, wherein the SiGe film has a greater silicon content at the interface with the substrate than at other points in the film.

Claim 26: The method of claim 19, wherein the silicon precursor is selected from the group consisting of silane, disilane, trisilane, chlorosilane, dichlorosilane, trichlorosilane, and tetrachlorosilane.

Claim 27: The method of claim 19, wherein the germanium source is selected from the group consisting of germane, digermane, trigermane, chlorogermane, dichlorogermane, trichlorogermane, and tetrachlorogermane.

Claim 28: The method of claim 19, wherein the etchant comprises hydrogen chloride.

Claim 29: The method of claim 19, wherein the germanium content of the blanket SiGe film is between approximately 20% and approximately 100%.

Claim 30: The method of claim 19, wherein the germanium content of the SiGe film is between approximately 40% and approximately 80%.

Claim 31: The method of claim 19, wherein the etchant is supplied into the chamber at a rate between approximately 25 sccm and 50 sccm.

Claim 32: The method of claim 19, wherein the chamber has a temperature between approximately 350°C and approximately 1100°C during deposition of the SiGe film.

Claim 33: The method of claim 19, wherein the chamber has a temperature between approximately 800°C and approximately 900°C during deposition of the SiGe film.

Claim 34: The method of claim 19, wherein the chamber has a pressure between approximately 0.200 Torr and approximately 850 Torr during deposition of the SiGe film.

Claim 35: The method of claim 19, wherein the chamber has a pressure between approximately 1 Torr and approximately 100 Torr during deposition of the SiGe film.

Claim 36: The method of claim 19, wherein the SiGe film has a surface roughness of less than approximately 40 Å rms.

Claim 37: The method of claim 19, wherein the SiGe film has a surface roughness of less than approximately 30 Å rms.

Claim 38: The method of claim 19, wherein the SiGe film has a surface roughness of less than approximately 20 Å rms.

Claim 39: A method of blanket depositing a SiGe film comprising:

intermixing a silicon source gas and a germanium source gas;

adding an etchant to the intermixed source gases to from a gaseous precursor mixture;

flowing the gaseous precursor mixture over a substrate under chemical vapor deposition conditions; and

depositing a blanket layer of epitaxial SiGe onto the substrate;

wherein the mass of etchant added to the intermixed source gases is less than a mass of etchant added to the intermixed source gases in a selective deposition process.

Claim 40: The method of claim 39, wherein the mass of etchant added to the intermixed source gases is less than the mass of the intermixed source gases.

Claim 41: The method of claim 39, wherein the substrate is positioned within a chemical vapor deposition chamber.

Claim 42: The method of claim 39, wherein the substrate is positioned within a chemical vapor deposition chamber, and wherein the etchant is supplied to the chamber at between approximately 1 sccm and approximately 200 sccm.

Claim 43: The method of claim 39, wherein the substrate is positioned within a chemical vapor deposition chamber, and wherein the etchant is supplied to the chamber at between approximately 25 sccm and approximately 50 sccm.

Claim 44: A method of blanket depositing a film comprising:

providing a single crystal substrate in a chemical vapor deposition chamber;

supplying a mass of germanium source gas into the chamber;

supplying a mass of etchant into the chamber, wherein the mass of etchant supplied is less than the mass of germanium source gas; and

blanket depositing a film over the single crystal substrate, wherein the film comprises germanium.

Claim 45: The method of claim 44, wherein the germanium content of the film is between approximately 20% and approximately 100%.

Claim 46: The method of claim 44, wherein the film has a surface roughness of less than approximately 40 Å rms.

Claim 47: The method of claim 44, wherein the film has a surface roughness of less than approximately 20 Å rms.

Claim 48: The method of claim 44, wherein the film has an etch pit density of less than 10^7 defects cm^{-2}.

Claim 49: The method of claim 44, wherein the film has an etch pit density of less than 10^5 defects cm^{-2}.

Claim 50: The method of claim 44, wherein the film has a greater degree of planarity as compared to a reference film deposited under comparable conditions, except in the absence of the etchant.

Claim 51: The method of claim 44, wherein the single crystal substrate is a bare wafer.

Claim 52: The method of claim 44, wherein the singe crystal substrate is patterned with windows of single crystal material with a dielectric constant.

Claim 53: The method of claim 44, further comprising supplying a mass of silicon source gas into the chamber.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.

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